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still lower, it reaches water, which is similarly forced upward and may flow at the surface. The water is always a brine, because, occupying a closed reservoir, it has no circulation and has been dissolving for ages the soluble minerals contained in the rocks; and it is thus contrasted with the potable waters of artesian wells, which contain comparatively little mineral matter, because they are parts of an underground circulation and their sojourn within the rocks is comparatively brief. An ordinary artesian water does not rise in wells everywhere to the same height, the pressure, or head, diminishing as distance increases from the source of supply; but the stagnant brine underlying a body of petroleum is everywhere subject to the same pressure, and will rise to the same height in any well to which it has access. This principle is intimately related to the pressure under which gas escapes from a well and its knowledge has been found of great practical value to the natural gas industry.

It follows from the theory, and it is also a matter of observation, that as the gas in a reservoir is drawn off through wells, the underlying oil and brine rise to take its place, and when the local store of gas has been exhausted, the wells either produce oil or are flooded by brine.

With the demonstration of this theory the earlier idea, that gas was forced outward merely by its own elasticity, and that it was generated in subterranean laboratories from fossil organic matter as rapidly as it escaped, was completely disproved. It became evident that the supply of gas in each reservoir was definitely limited; that if once exhausted, it could never be restored; that economy was required in the use of natural gas; as with any other resource; and that the folly which permitted it to escape freely to the atmosphere was also a crime. That such criminal and disastrous folly was actually perpetrated in

most of the gas fields of northern Ohio and central Indiana was not the fault of Dr. Orton, who early sounded the note of warning, and strenuously combated the infatuation of the well owners.

Of the high esteem in which Orton was held by his colleagues in scientific labor you are already aware. The Geological Society of America, an organization including the leading geologists of the continent, chose him as its president, to serve for the year 1897; the American Association for the Advancement of Science, foremost in importance among American scientific bodies, called him to the chair of its geologic section in 1885, and bestowed its highest office in the last year of his life. Even in his own country he was not without honor.

G. K. GILBERT.

*ADDRESS OF THE PRESIDENT BEFORE THE
AMERICAN SOCIETY OF NATURALISTS.**

BEARING in mind that we have with us this evening representatives of all branches of natural science, it seems better that I should not attempt to give here a sketch of the progress of botany nor discuss the special problems which botanists are trying to solve. Botany is certainly progressing, but progress is not hastened by stopping too frequently to consider just how much progress has been made. As far as questions of botanical research are concerned the past year has not been marked by any startling discovery, but it has been rather a year of transition, and the work done may be expected to bear mature fruit later. The most striking feature of the past year in our own country has been the publication of a remarkably large number of treatises of an educational character in which the results of recent botanical work have been presented in a fresh and attractive form, but this is evidently not an occasion on which

* New Haven, December 28, 1899.

one should speak of their merits or point out their defects.

Instead of calling your attention to any special phase of botany I shall take the liberty of presenting a few considerations suggested by a comparison of the different methods of organization of universities and other scientific establishments in this country and in Europe. Such considerations, although they apply to all advanced studies and research, whether literary or scientific, are not to be considered beyond our province, for in more ways than may at first be supposed there is a community of learning, and any method or organization which genuinely promotes one form of knowledge tends to promote the study of other branches. I say genuinely because I do not believe that a system which professes to encourage the exclusive study of one or a few subjects will in the end be successful.

Although any organization may be better than no organization at all, there is a possibility of pushing organization to an extreme, and, by putting too many wheels into our educational clocks, produce a disastrous amount of friction. Organization should be carried so far that the knowledge which has been acquired slowly and laboriously from experience and research is systematized in such a way that the student may be able to learn all that is possible without loss of time, and the investigator, well informed as to what is already known, be able to take up the thread of the unknown and unravel it to the greatest advantage. When organization goes so far as to dictate just who should do certain things and to prescribe stereotyped ways of work, it is always disastrous. Since a good organization of the forces at our command is probably the most efficient means of securing steady progress in science, an examination of different modes of organization should prove instructive.

Without entering into the futile question

of the relative inherent capacities of the scientific men of different European nations, it is safe to say that we should all agree that, in point of scientific organization, the German universities surpass all others. Probably most of my hearers have, at some time, pursued their studies in Europe, and, if they have attended German universities rather than those of other countries, it was because they were convinced that, however eminent individual professors might be elsewhere, Germany was the place where the university system would enable them to obtain most readily the results of modern science and to prepare themselves for investigation. Although we Americans are supposed to have a sufficiently high opinion of our own abilities and our own institutions, it is certainly true that we are willing to learn from other nations. A considerable portion of the Americans who have studied in Germany have on their return home a feeling that the German university system is better than our own and desire to introduce German methods, and it is not necessary to remind you of the great influence which such a feeling has had on our own universities. Our social and intellectual conditions, however, do not permit us to transform our universities completely into institutions like German universities, and there has grown up with us a system which is peculiarly American, of which the full significance has in an important respect often been overlooked.

When one asks how our universities differ from those in Germany and other European countries, the answer generally given is that students who enter foreign universities have had a more thorough preliminary training than our own; that the instructors, taken as a whole, have a more profound knowledge of their specialties; and that the equipment in the form of libraries, laboratories and museums is more complete than in this country. Were these

the only respects in which our own universities differ from those of Germany, for instance, we might believe that the differences would disappear in the near future. Our preparatory schools, it is claimed, are improving; our university instructors are becoming better equipped for their special work, and, at least as far as natural history is concerned, our libraries and laboratories are numerous and some of them are hardly inferior, for all practical purposes, to those of the best European universities. Were the differences I have mentioned the only ones, we could say with truth that there is no radical difference between our universities and those of Germany, but merely a difference in the comparative development, which time would obliterate. There is, however, another fundamental difference, on which it seems to me too little stress has been laid, a difference which, as far as I can see, tends to become more marked or which, at least, shows no signs of diminution in the near future. I refer to the method of university government. Strange to say, although we are living in a republic, the whole tendency in our colleges and universities is towards a more autocratic form, while in Germany, on the other hand, it is of a more democratic character. In other words, excluding the purely political question of supporting or, at least, of not interfering with the administrative measures of the government in power, the instructing, the learned body, the faculty, has in Germany more power in regard to appointments and the general policy of the university, while with us, the greater power lies with the president and the boards known variously as corporations, trustees and overseers. The German universities have no president, in our sense, but the presiding officer is selected annually from the body of professors in rotation. Nor is there in the English universities any officer corresponding to our college, or university,

president, the chancellorship being rather an honorary position than one of active duties.

The American president, on the other hand, is a true executive of such importance and intrusted with such power that the selection of a proper president is a vital question. If he is capable, the college is successful; if he is incapable, it quickly falls behind. The successful modern president is, furthermore, a very different person from the president of twenty-five or more years ago. Formerly the president was frequently a professor selected for his eminence as a scholar, due regard being paid to his orthodoxy. His position as president did not debar him from continuing to lecture as a professor. The modern president is less frequently selected from the body of professors, and, if so selected, he is chosen not so much on account of his eminence in science or literature as from his presumed ability as an administrator. In becoming president he almost of necessity relinquishes his position as a lecturer. He must above all things be a man of good business head whose previous experience has given him a knowledge of educational methods. It is the president rather than the faculty who, in the opinion of the public, shapes the policy of the American university, for, although, accepting the suggestions of the faculty, he may adopt them as his own policy, he is not under the necessity of doing so, and the skillful president is usually successful in inducing the faculty to recommend the policy which he thinks advisable.

The preponderating influence of the president and financial board as compared with that of the faculty or board of instructors seems to me to be the most striking feature in our American system as compared with the European university system. The system has gradually developed with us from the time when one person combined

the functions of professor and presiding officer. During the last 15 or 20 years the relative importance of the president has been more marked, owing to the fact that by the transformation of the older colleges into universities the amount of administrative work has been greatly increased, and with it has come the increasing necessity of depending more and more on the intelligence and activity of a single mind as supervisor and administrator. Furthermore, the remarkable increase in the number of colleges and universities, none of them with sufficient endowment to provide the elaborate equipment and large body of instructors required in a modern university, has brought about a competition between different institutions, each struggling to outdo the others, so that the college president has been forced to become a 'hustler,' to borrow an expression from the business world, and he is obliged to see that his own institution is not outdone by others in the scramble for private and public money to carry on establishments requiring additional sums for proper endowment. Whether we like it or not, I think it will be admitted that what I have described as peculiarly the American system of university organization is one which we must accept as unavoidable in this country, and there is no probability that the system will be changed essentially in a short time. That being the case, it is our duty to adapt ourselves to it and make the best possible use of it, not expecting that we shall be able to copy closely the systems of other countries except in certain details, which, however, are important.

The great charm of the German university hitherto has been what has been described as the intellectual atmosphere, the prevailing desire of pursuing learning and investigation for their own sake, which, however, does not unfit the Germans for the successful application of science in in-

dustrial and practical fields. We miss in our own universities this universal desire for investigation, which is with us confined to a certain number of persons who are very enthusiastic, to be sure, but are in most cases obliged to justify themselves in the eyes of those who do not understand the value of investigation.

Fashion and the natural tendency to imitate others has, however, done very much for us in recent years in aid of investigation, for, while it may be next to impossible to induce the governing board of a university to spend money on investigation for its own sake, it is a comparatively easy matter to convince them that they must make provision for original work because some other institution has done so and is thereby attracting public attention. If original research can be used as a means for advertising a university, there is no doubt that it will be encouraged, and, fortunately, as it turns out, it is a very good advertisement, even better than victories in athletics. The really successful American universities are those in which the most original work is done. The trouble is that if one looks upon research mainly as an advertising medium, one is apt to demand quantity rather than quality, and to regard the number of papers published annually as the standard of scientific activity.

The pursuit of science for its own sake which characterizes the German universities is one of the results of their form of organization. The faculty, the learned body, shape their own policy more than is the case with us, and they recognize the intrinsic value of research. With us it is necessary, through the president, to convince the corporation and trustees of its value before much can be done, and they, being for the greater part business men or professional men, rather than scholars, are apt to consider that research is valuable only in so far as it is what they call prac-

tical. In this view they undoubtedly represent the American public, and it is from the public that the money must be obtained for carrying on research, either directly from private individuals in the case of endowed universities, or indirectly through the legislatures as representing the public in the case of the State universities. The misfortune is that the word practical means nothing in particular, for even abstract science sooner or later has a practical application, and it often happens that what is supposed to be very practical is merely empiricism which a thorough theoretical study would show to be false.

It would be unjust not to admit that there is something to be said on the side of governing boards in the attitude which they take towards research. Research is expensive, and when the professors ask that it be encouraged that means something more than sympathetic words. It means money or relief from an excessive amount of teaching, which is the same thing as money, for some one must be paid to do the teaching. It can hardly be supposed that the governing boards are really opposed to research, although they at times overrate the value of formal instruction as compared with research. They feel that they have no money to spend, which is, unfortunately, often true, and, on the other hand, they do not understand the absorbing nature of research and the necessity for giving one's close attention to it. So long as research is subordinated to other work it cannot accomplish the best results, and any occupation, whether it be excessive routine work in the way of lectures or laboratory instruction, or whether it be the enforced necessity of going about and talking to private individuals or members of legislatures for the purpose of obtaining money for a proper equipment, stands in the way of, if it does not entirely check, research. In Germany the professors are able to pursue their original work

without feeling that one of their functions is the raising of money for carrying on the work. Unfortunately, in most of our scientific establishments, in speaking of the professors, the double-headed question is not unfrequently asked: What work are they doing and how much money have they raised for the support of their laboratories? For the credit of American science, it is to be hoped that this question will soon be reduced to the simple inquiry as to the work done.

Hitherto I have spoken of American colleges and universities somewhat indiscriminately, since it is not possible to distinguish between them, some colleges not differing essentially from universities, while some so-called universities are not universities in any sense. By whatever name they are called my remarks apply to institutions in which advanced instruction is given, looking ultimately to original research by specially qualified students and by the instructors, and in the same class should be included the better scientific schools, for, although it is hardly proper strictly to compare their organization with that of a German university, many of the anomalous conditions found in our universities and colleges are found also in our scientific schools. I have assumed that all such institutions have the double function of teaching and investigation, a dogmatic view perhaps, but one with which I presume most, if not all, of those present this evening are in sympathy, although there are people, especially some who think that they are very practical, who hold a different opinion.

We believe that the two functions must be combined in a university because we know from experience that, in the cases where instruction is considered to be the sole function, stagnation, not progress, is the result. On the other hand, if research were the sole function of a university, it would be difficult to see where else those desiring to

become investigators could be properly trained. The real question is as to the amount of instruction.

It has been the custom in comparing our universities with those of Germany to lament the absence of uniform standards of admission requirements and of qualifications for higher degrees in this country. If by that is meant that it is to be regretted that our standards are not higher, the lamentation is justified. But if, as some think, what we need is a uniform standard in these respects, to be enforced by agreement of the different universities or initiated by the establishment of a national university, I, for one, am thankful that we have no such uniformity. The present uniformity in Germany is the result of an old civilization, and the prevalence of similar educational and intellectual conditions for many years. In the course of time our educational conditions will become more and more uniform and we may have, perhaps, uniform standards of admission and graduation, but, if so, they will be the results of a natural development, not of prescription. So long as the social and political conditions of the different parts of our country differ as they do, real uniformity in university standards is out of the question. Even in sections of limited area the attempts at enforcing uniformity among the different colleges have at times shown the ease with which rules can be kept in theory and yet broken in practice.

The possibility of establishing a genuine national university superior to all others in equipment and authority seems to most of those interested in educational matters to be remote, but, were it possible to have such a university, one could hardly imagine a greater misfortune to learning in America. One need only glance at the condition of things in Germany and France to recognize the benumbing effect of concentrating in one place, especially if it be the political cap-

ital, the greater portion of the scientific establishments. The wide-spread intellectual activity of Germany is, I think, mainly due to the existence in times past of many scattered universities, some better than others, no one, however, superior to all the rest, but all centers of learning, generous rivals in the promotion of knowledge. Whether under imperial Germany the concentration of resources on fewer universities, with a tendency to still greater concentration hereafter, may not have an unfavorable effect on the nation in the long run, is a question which the future must answer. That the concentration of scientific work and workers in Paris has had an injurious effect on France is evident to the French themselves, and they have in recent years made efforts to strengthen the universities in other parts of France. Our country is so large and so varied in population and occupation that we need many independent centers of learning and numerous universities, zealous in promoting knowledge, but not subordinated to a national university, either directly or indirectly, by the expenditure of national funds on a single institution. Whether such universities should be privately endowed or supported by the States is a question to be settled in each case by the locality and tradition.

If it is true that the promotion of science and learning in a country like ours is best accomplished by the existence of numerous independent universities, there is still a large field of research on which government funds may be legitimately spent. The principle that what can be well done by privately endowed universities, or by those supported by the States, had better be left to them rather than be undertaken by the national government, seems to me to be a sound one and to be in accord with the spirit in which our government was founded. Centralization in science, as in government, may be necessary at times, but is to be

avoided when possible. There must, however, always be questions affecting the national welfare which it is undoubtedly the function of the general government to investigate. The study of contagious diseases of man and animals, involving as it does questions of quarantine and other sanitary regulations, which may affect any or all the States, and the study of plant diseases, however caused, and the means of prevention, are good instances of the kind of work which should be undertaken by the national government, for they are of such eminently practical nature and so general in their application that it is important that the government should have constantly in its service experts capable of studying them and of giving at short notice information that may be needed. The theoretical aspects of the subjects mentioned and the study of certain special cases may profitably be undertaken by private or State institutions, but the resources and authority of the general government are needed for the obtaining and spreading of information and the enforcement of preventive or remedial measures. It is an important duty of our universities and scientific schools to train up a body of young men capable of entering the different governmental bureaus as scientific experts, that is to say in the lower grades, for it is not supposed that without a more or less lengthy active service in the bureaus themselves one would be prepared to fill the higher positions. In Germany there seems to be no difficulty in finding among the graduates of universities and technical schools well-trained young men for the scientific establishments of the government. If things are not in so satisfactory a state here it is due, in part, to the very rapid enlargement of the scope of government work in recent years, and there is no reason to suppose that before long the supply of well-trained young men will not equal the demand.

In my remarks this evening I have felt free to state what, to the best of my knowledge, seems to be the condition of our scientific organization, especially in our universities; but in what I have said I have endeavored merely to describe the situation viewed generally, and, if I have taken this occasion to refer to some points in which our system might be improved, I have done so without reference, either expressed or implied, to any institution or locality, but because I cannot help feeling that a plain statement of certain difficulties from which many, if not most of us, suffer is the first step to be taken if we are to expect improvement. I have described the older German universities as generous rivals in the promotion of knowledge. From conditions beyond our control we are at present in a condition of unrest and feverish ambition, each university striving, on insufficient means, to do all that any other university is doing. When shall we become cool-headed enough to do well and thoroughly what our means permit, and wait patiently for the time when we can expand farther without too great tension or attenuation of the resources now at our command?

W. G. FARLOW.

HARVARD UNIVERSITY.

INHIBITING ACTION OF OXIDASE UPON
DIASTASE.

IN the disease of the tobacco leaf known as Calico, or Mosaic, the lighter-colored areas are found to contain more starch in the form of granules than do the green areas of the same leaf. This is very peculiar, inasmuch as the chloroplasts of the light-colored areas are evidently in an unhealthy condition.

In an article published in the *Centralblatt für Bakteriologie*, II Abt. Bd. V., No. 22, I have pointed out the fact that these light-colored cells exhibit much more oxidizing activity than do the green cells of the same